

WOODLAND-ERA CLAY PROCUREMENT IN THE CAROLINAS: A CHEMICAL AND MINERALOGICAL STUDY OF CLAYS AND CERAMICS

Theresa E. McReynolds¹ and Joseph M. Herbert²

¹Research Laboratories of Archaeology, University of North Carolina, Chapel Hill, NC 27599, ²Cultural Resources Program, Environmental Sustainment Division, Fort Bragg, NC, 28310.

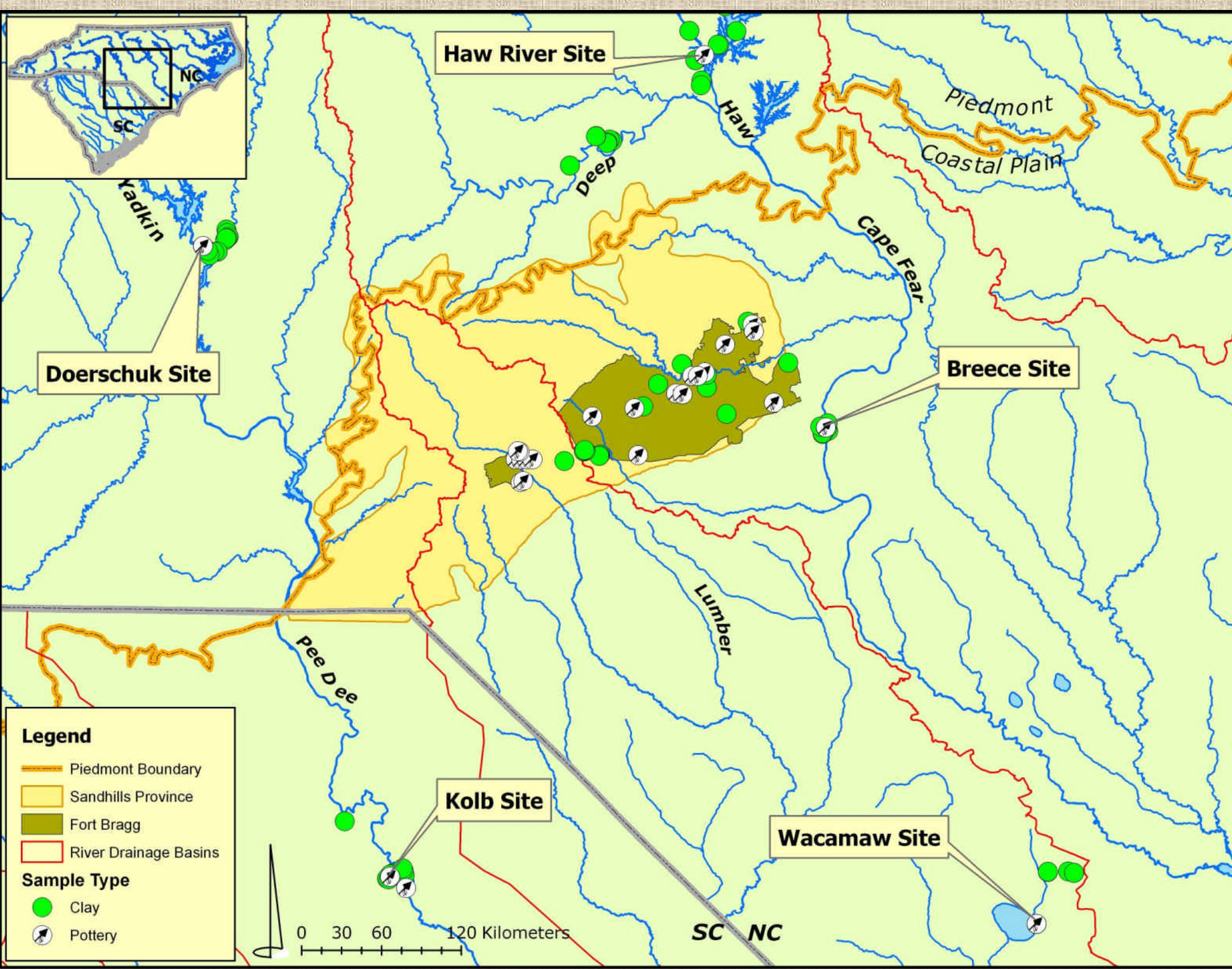
Project Overview

Introduction

This study compares local clay sources with pottery from sites in the Carolina Piedmont, Coastal Plain, and Sandhills to explore patterns of resource acquisition and residential mobility among people living in the Fort Bragg region of the Sandhills during the Woodland era (ca. 1500 B.C.– A.D. 1600). Neutron activation (NAA), x-ray diffraction (XRD), and petrographic analyses were conducted to characterize regional variation in the chemical and mineral constituents of clay resources and to assess the nature of correspondence between clay resources and prehistoric pottery from each region. Performance trials evaluated the usefulness of each clay sample for making pottery.

Research Questions

- Are specific clay-source regions recognizable on the basis of chemical and mineralogical composition?
- If so, how do they correlate with pottery from archaeological sites?



Distribution of clay samples and the archaeological sites from which the pottery samples were drawn.

The Sample

A total of 70 classifiable pottery samples was chosen from 21 archaeological sites (Table 1). Ten pottery samples were selected from each of five key sites in the Piedmont and Coastal Plain. The sherds from each of these sites are assumed to typify the pottery and represent the clay sources from the river basins in which they occur. An additional 20 sherds were selected from sites in the Sandhills.

A total of 84 clay samples was collected (Table 1). Based on ethnographic evidence (Arnold 1985), the sampling strategy focused on clay sources adjacent to sites from which pottery samples were selected.

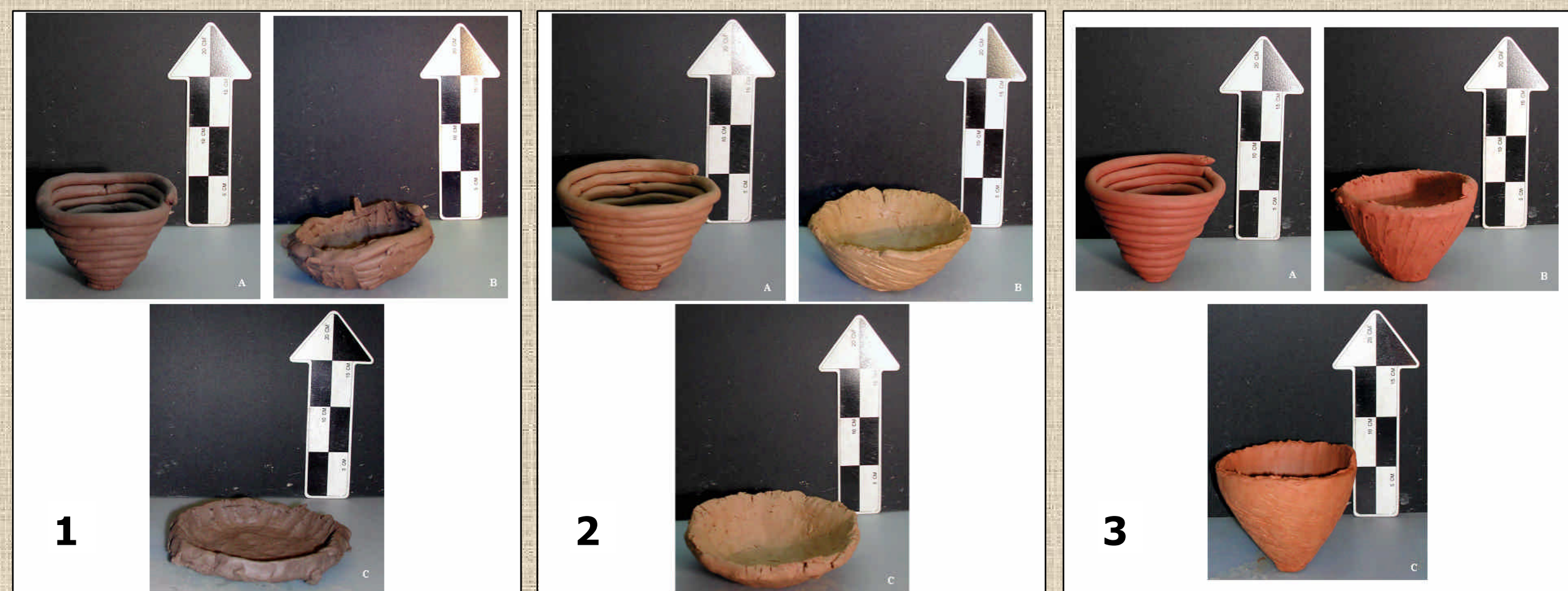
Table 1. Distribution of Samples		Clays		
Province:		Sherds	Collected	Analyzed
River Basin	Site(s)	(n)	(n)	(n)
Piedmont:				
Haw-Cape Fear	Haw River	10	31	10
Yadkin-Pee Dee	Doerschuk	10	12	5
Coastal Plain:				
Haw-Cape Fear	Breece	10	6	5
Lumber	Waccamaw sites	10	5	5
Yadkin-Pee Dee	Kolb	10	9	5
Sandhills:				
Haw-Cape Fear	Fort Bragg sites	12	21	12
Lumber	Camp Mackall sites	8	0	0
Total		70	84	42

The Anthropological Analog

Each clay sample was subjected to a series of performance and replication trials to assess its suitability for making coiled, paddle-and-anvil-built pots. The plasticity and strength of each clay sample was initially judged on the basis of coil, ball and loop tests. Based on performance results, each sample was assigned to one of four classes characterizing its workability as lean (a), moderately lean (b), good (c) or fat.



Initial trials were refined by making small semi-conical pots by coiling (a), annealing by hand (b) and padding (c). Results reveal that even clays exhibiting good workability in coil, ball and loop tests, may not have the right combination of strength and plasticity for making pots (1 and 2). Clays that are suitable for making pots neither slumped nor cracked during annealing and padding (3).



Replication tests involved building, drying and firing coil-built vessels. Samples that performed poorly in the trials and were found to be inadequate for building pots, were considered poor analogs for modeling prehistoric practices and were eliminated from further analyses.



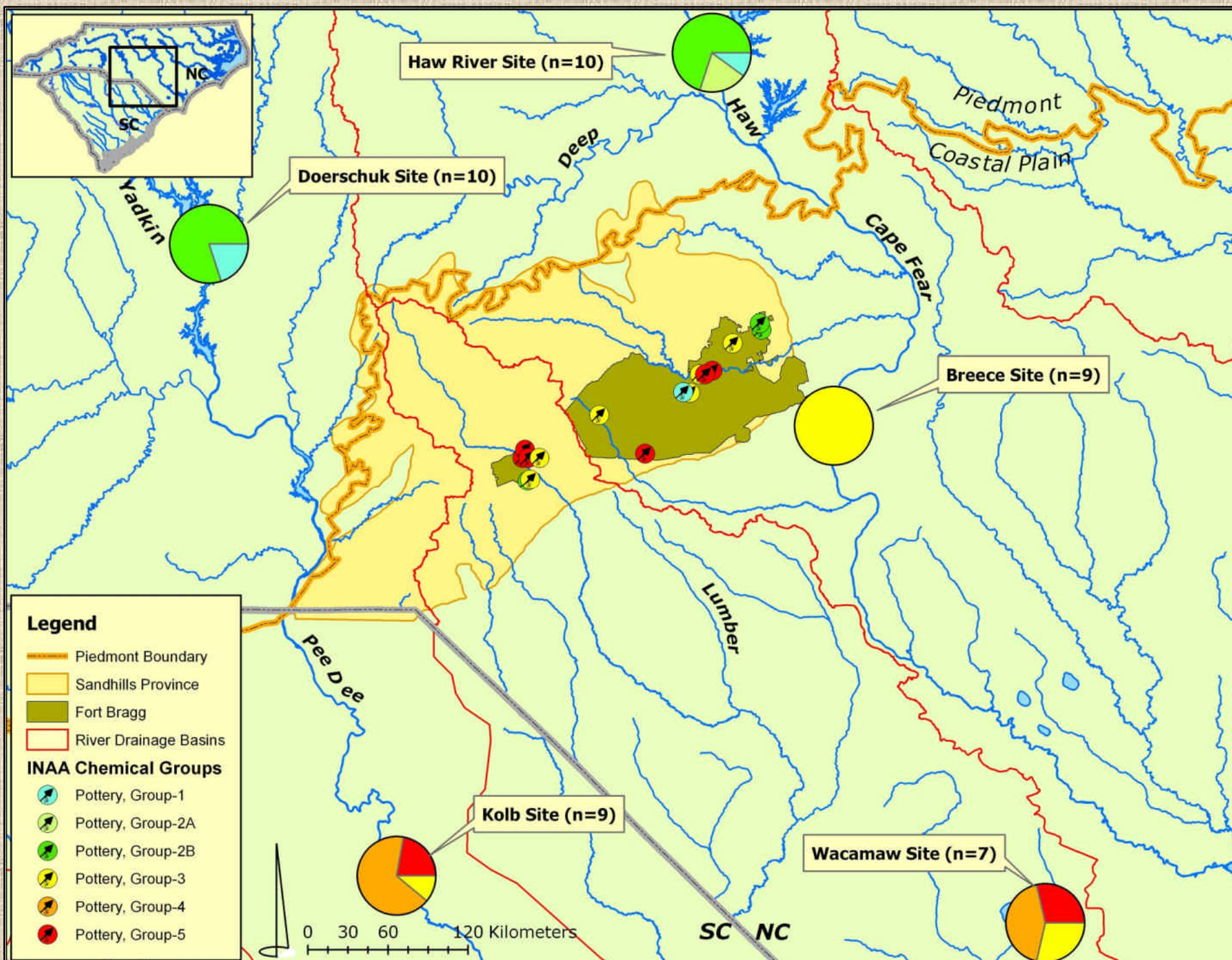
Overall, Sandhills clay samples performed poorly and Coastal Plain samples from the Lumber and Pee Dee drainages performed the best (Table 2). The very best samples, however, came from the Haw River area of the Piedmont. Only one good clay sample came from the Fort Bragg area, and in fact the majority of Sandhills clays lack the plasticity necessary for building pots.

Table 2. Plasticity of Clay Samples				
Province:	Lean	Mod Lean	Good	Fat
River Basin	(n)	(n)	(n)	(n)
Piedmont:				
Haw-Cape Fear	2	22	6	1
Yadkin-Pee Dee	3	9	0	0
Coastal Plain:				
Haw-Cape Fear	0	3	3	0
Lumber	0	0	5	0
Yadkin-Pee Dee	0	1	6	2
Sandhills:				
Haw-Cape Fear	12	8	1	0
Total	17	43	21	3

Clay and Ceramic Chemistry through Neutron Activation Analysis

Neutron activation analysis (NAA) was employed to identify chemical differences between ceramic samples and clay resource areas. These data were explored through standard procedures to assess the similarity and dissimilarity among the regions sampled (Bieber et al. 1976; Bishop and Neff 1989; Harbottle 1976; Neff 1992; Sayre 1975; Speakman and Glascock 2006).

NAA provided elemental concentration values for 30 detectable elements in the ceramic and clay samples. Principal components analysis (PCA) of the dataset indicates that there are six recognizable compositional groups, separation of which is largely based on calcium (Ca), sodium (Na) and, to a lesser extent, manganese (Mn) concentrations. When the number of elements considered is reduced from 30 to 10, these groups are more clearly differentiated. Fifty-five of the 70 pottery specimens and 36 of the 42 clay samples can be assigned to one of these six groups.



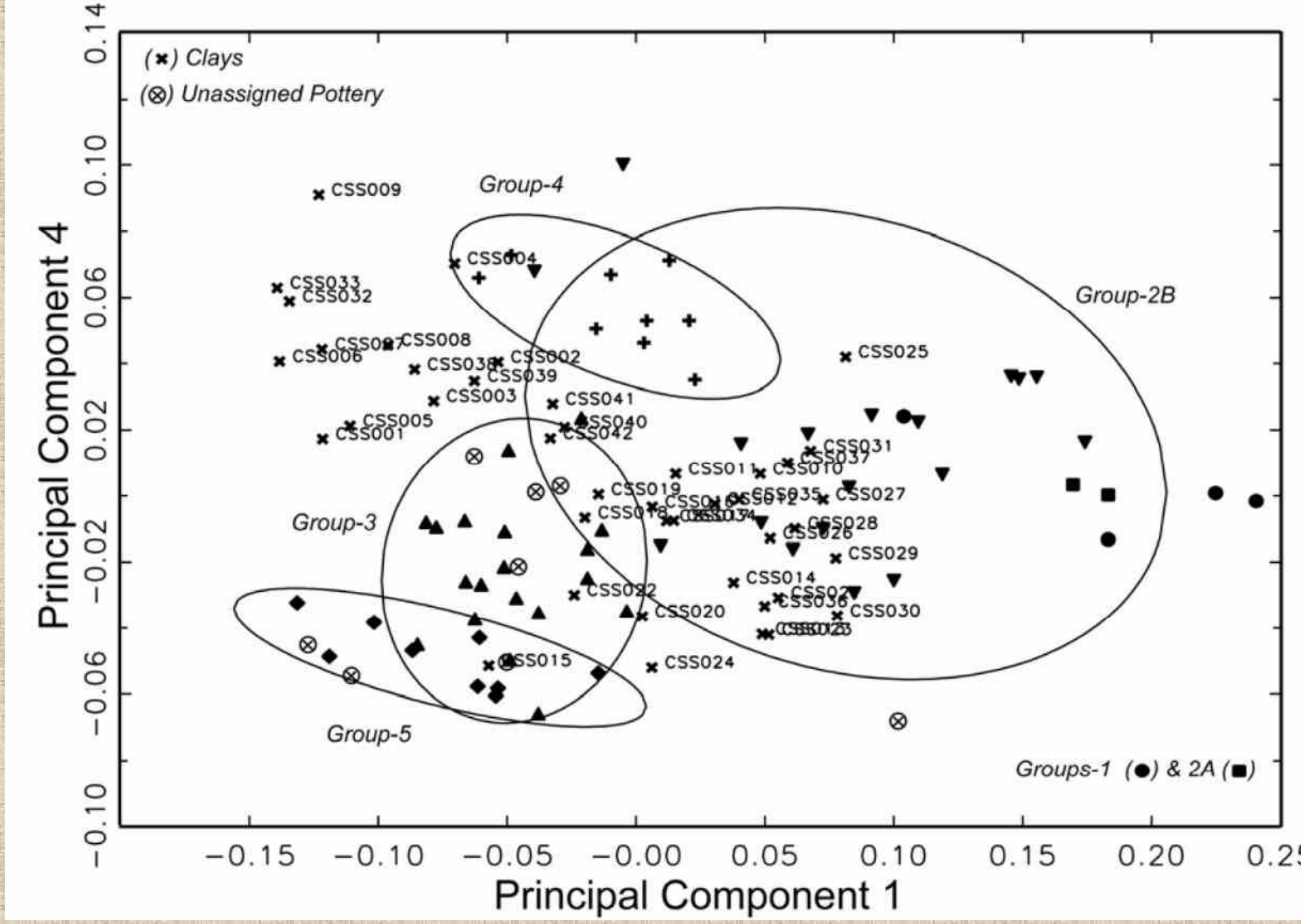
Pottery samples assigned to chemical groups based on Mahalanobis distance and posterior classification derived from PC01-PC04 using the abbreviated element list.

Pottery

Samples from the Piedmont fall primarily into Chemical Group 2B, characterized by relatively high Ca and Mn concentrations and low Na concentrations. Mineralogical analyses reveal that the source of the Ca in these samples is igneous rock inclusions, some of which may have been added as tempering material.

Coastal Plain sherds are chemically distinct in comparison to Piedmont sherds. The Breece samples from the middle Cape Fear drainage are homogeneous: all assigned specimens belong to Group 3, which exhibits intermediate concentrations of Ca, Na, and Mn. This homogeneity suggests a specific local clay source in the vicinity of the site. In contrast, samples from the Kolb and Waccamaw sites tend to fall into Groups 4 and 5. Group 4 is characterized by high Ca and intermediate Na and Mn, while Group 5 exhibits low Ca and intermediate Na concentrations.

Significantly, the Sandhills samples are the most chemically heterogeneous. Fort Bragg sherds fall into Groups 1, 2B, 3, and 5. The presence of four distinct chemical groups in the Sandhills indicates that potters in this region utilized clays from multiple source locations.



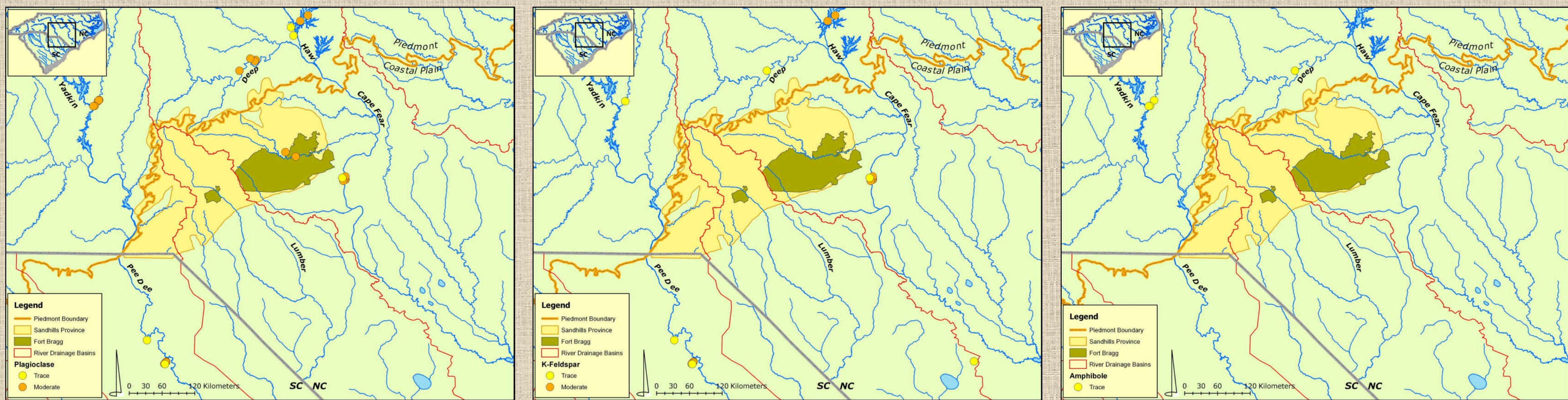
Plot of principal components 1 and 4 derived from PCA of the pottery and clay samples. Ellipses are drawn at the 90% confidence interval. (From Speakman and Glascock 2006.)

Clay Mineralogy through X-ray Diffraction

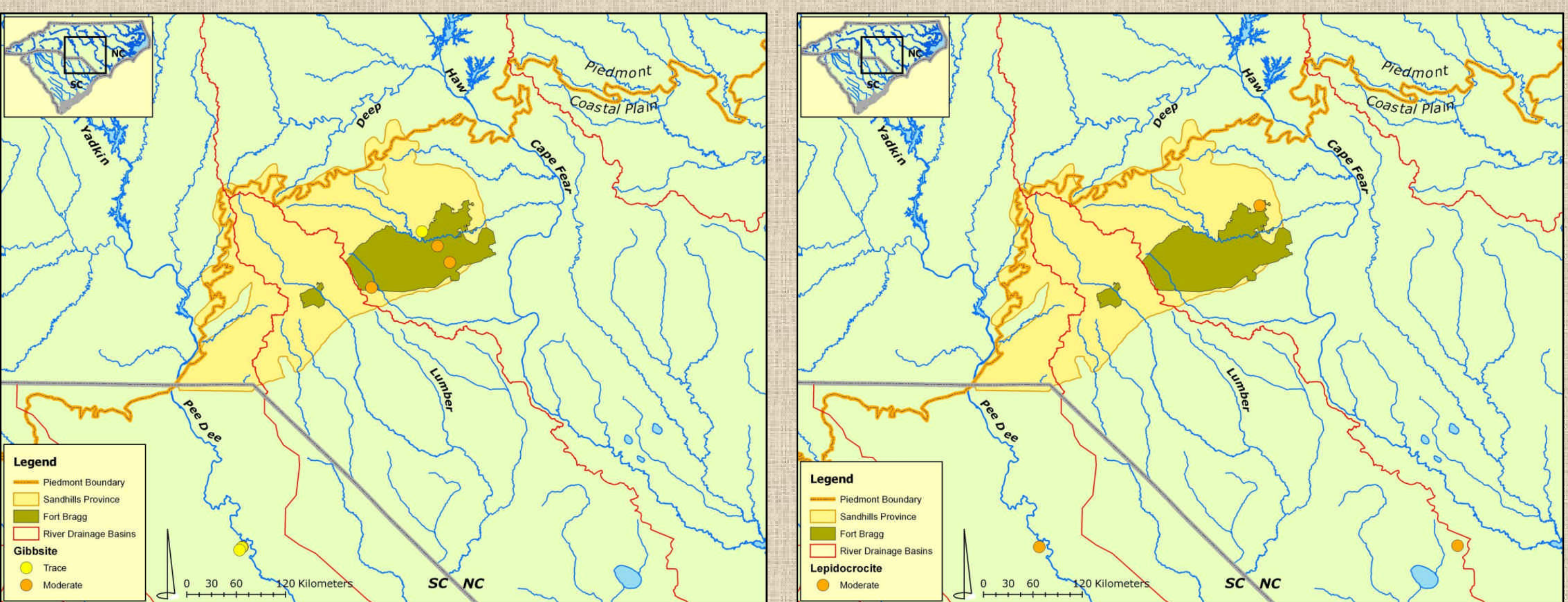
To further distinguish clay resource areas, x-ray diffraction (XRD) was employed to identify the relative abundance of ten crystalline minerals in the clay samples. The generated ordinal data were mapped to facilitate identification of geographic patterning.

With only a few exceptions, the distribution of plagioclase and K-feldspar tends to mirror the distribution of Chemical Group 2B clays found in the Piedmont and along Coastal Plain rivers originating in the Piedmont. Amphibole is also restricted to the Piedmont, but occurs primarily in the Yadkin drainage. Occurrences of gibbsite and lepidocrocite are limited to the Sandhills and Coastal Plain, although they appear in both Chemical Group 2B and Chemical Group 3 clays in these areas.

Quartz and clay minerals (chlorite, illite, kaolin, and smectite) occur almost everywhere and were consequently eliminated from further consideration at this stage in the study. It is anticipated that further study will yield interval-level data for these minerals. At present, it appears that the only clay samples with abundant kaolin are in the western portion of Fort Bragg.



The distribution of plagioclase, K-feldspar and amphibole is mostly in the Piedmont and on Coastal Plain rivers originating in the Piedmont.

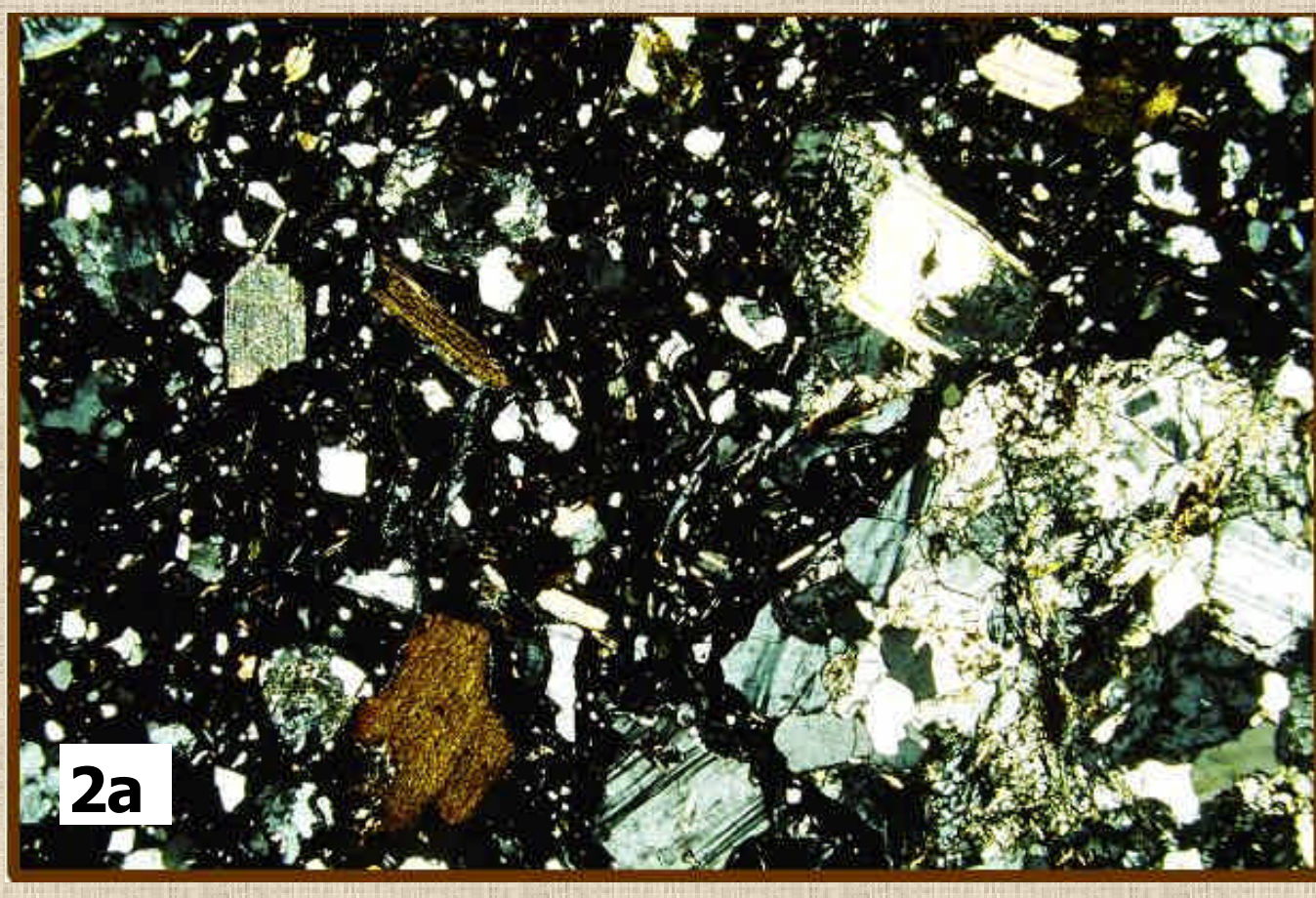


The distribution of gibbsite and lepidocrocite are limited to the Sandhills and Coastal Plain.

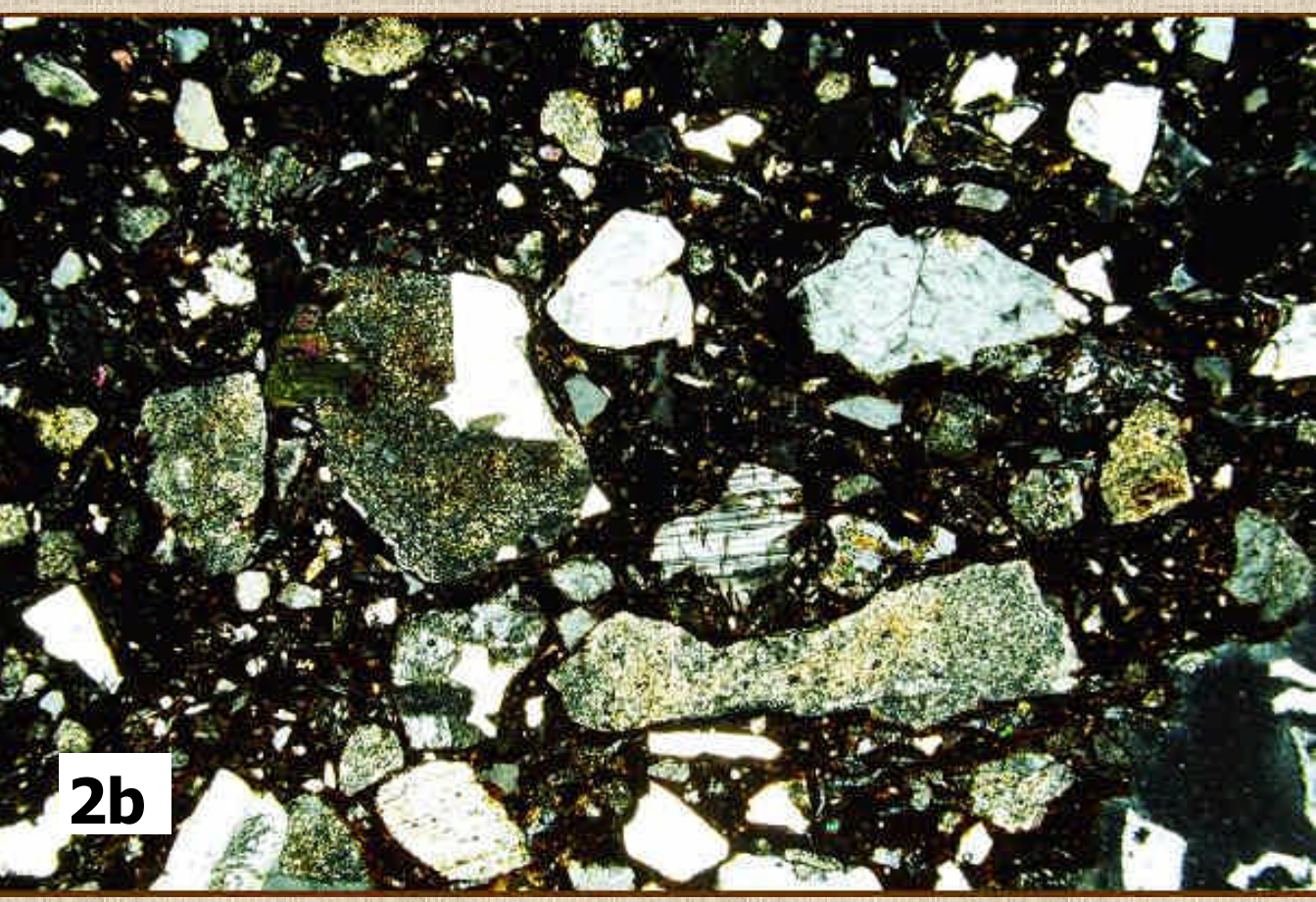
Clay and Ceramic Mineralogy through Petrography



Mineral Group 1 samples include a mineral suite composed primarily of pyroxene and plagioclase derived from mafic igneous rock.



Mineral Group 2 samples incorporate quartz, feldspar, biotite, muscovite, amphibole, opaque minerals, and igneous rock fragments. This group is divided into subgroups (2a and 2b) according to the mafic (amphibole, muscovite, and biotite) and opaque mineral content of the igneous rock fragments.

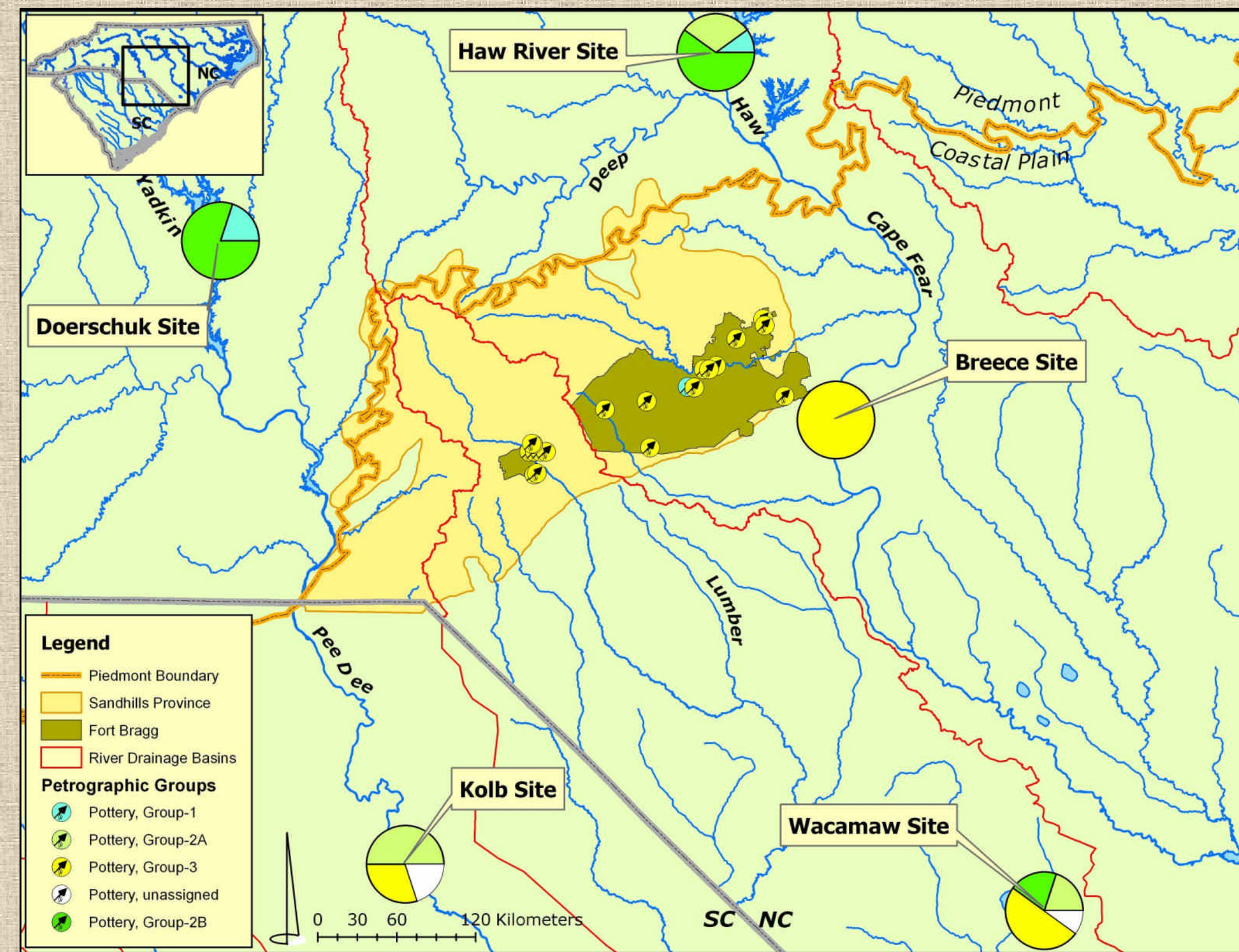


Mineral Group 3 samples contain muscovite, monocrystalline quartz, polygranular quartz rock fragments, and, in about half of the specimens, grog.

Pottery

Thin sections from the 70 pottery samples were submitted for petrographic analyses. These analyses indicate that the sherds can be classified according to three distinct mineral groups (Smith 2003), the distribution of which resembles the basic patterning suggested by NAA and XRD.

Piedmont sherds cluster in Mineral Groups 1, 2a and 2b. These groups are characterized by Ca-rich minerals such as clinopyroxene (augite), plagioclase (labradorite) and amphibole, and generally correspond to Ca-rich Chemical Groups 1, 2a, 2b and 4 (Table 3). In contrast, Breece and Sandhills sherds belong to quartz-rich Mineral Group 3, which corresponds to Ca-poor Chemical Groups 3 and 5. The Kolb and Waccamaw sherds show greater mineralogical variation, with some Ca-rich samples resembling Piedmont sherds and other samples resembling Ca-poor Coastal Plain specimens.



Distribution of pottery samples by mineral group.

Table 3. Contingency Table of Mineralogical and Chemical Groups		Chemical Group					
Mineral Group		1	2a	2b	4	3	5
		(n)	(n)	(n)	(n)	(n)	(n)
1		4					
2a			2	1	5	2	
2b			14	1	1	1	3
3				3	3	14	8
unx						2	1

Summary and Conclusions

The results of chemical and mineralogical analyses affirm that Piedmont and Coastal Plain clays are distinctive. Yet while Coastal Plain chemical and mineral groups are absent in the Piedmont, the reverse is not true. Piedmont chemical and mineral groups are found in the alluvial deposits of Coastal Plain rivers that drain the Piedmont.

In general, the chemical and mineral composition of pottery found on Piedmont sites reflects Piedmont clay sources and the pottery found on Coastal Plain sites reflects Coastal Plain clay sources. Interestingly, whereas alluvial Coastal Plain clays found in the vicinity of the Breece site exhibit elements and minerals derived from the Piedmont, the chemical and mineralogical composition of Breece pottery more closely approximates that of Coastal Plain pottery and clay sources.

This anomaly begs an anthropological explanation. We propose that local alluvial clays were not regularly used to make the pottery found at the Breece site, but rather that pottery vessels made of Coastal Plain clay were being transported to Breece from non-local sources. The fact that the Breece site is adjacent to the McLean Mound, a sand burial mound containing over 500 individuals interred over a period of perhaps several hundred years, informs our understanding of the potential for cultural interaction over a wide geographic region.

Likewise, pottery found in the Sandhills appears to represent vessels that were transported from Piedmont and Coastal Plain sources. NAA and petrographic analyses demonstrate that many of the sherds from Fort Bragg sites belong to Piedmont and Coastal Plain chemical and mineral groups, and our clay performance trials indicate that there is little serviceable clay in the Sandhills adequate for making pottery vessels.

These results indicate that pottery may have circulated over broad regions, suggesting high levels of residential mobility and implying that the acquisition or transportation of pottery from distant sources was an especially critical feature of Woodland-era subsistence in the Sandhills.

Acknowledgments

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